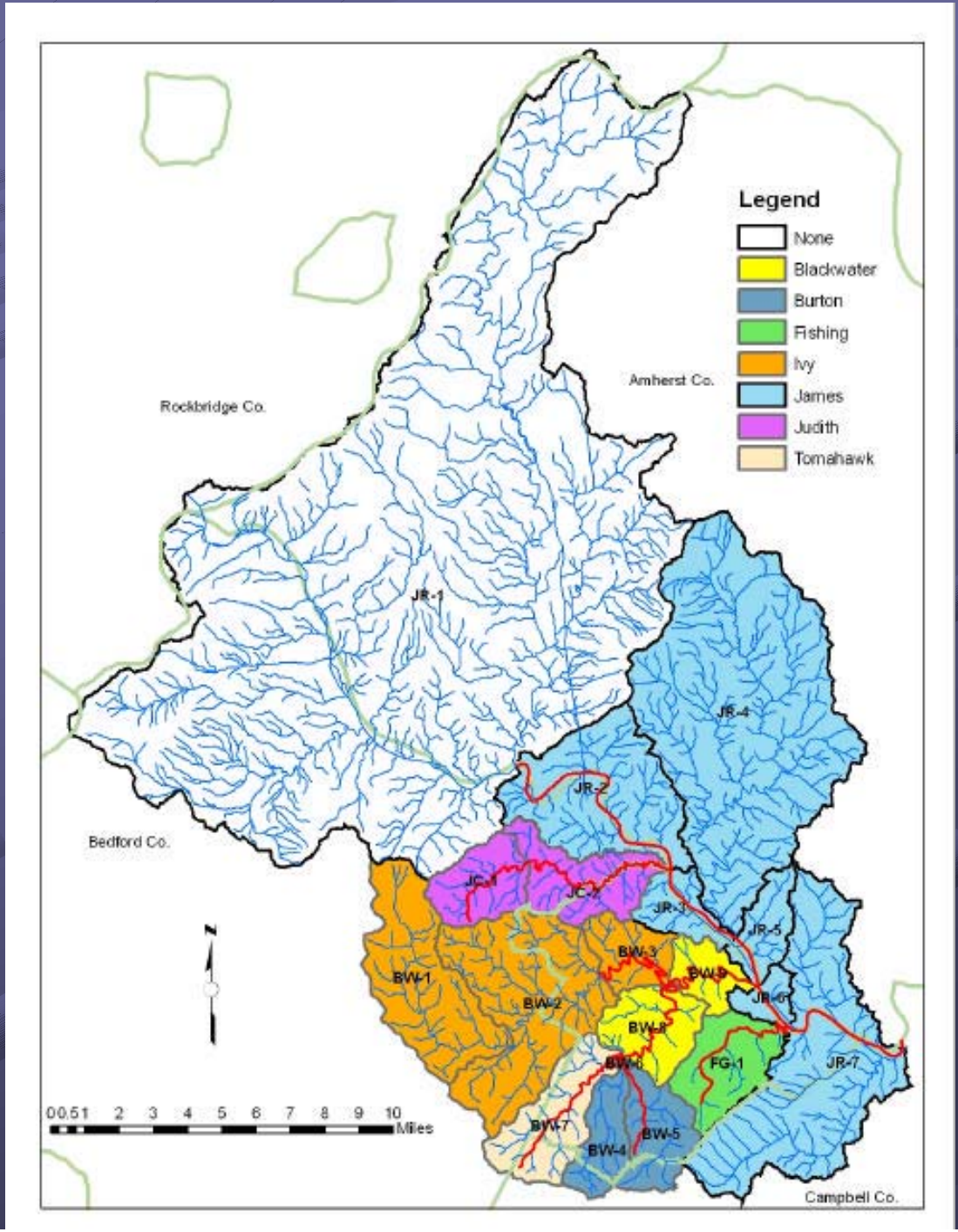
LYNCHBURG AREA BACTERIA TMDL DEVELOPMENT

Virginia Department of Environmental Quality
Virginia's Region 2000 Local Government Council
Engineering Concepts, Inc.

TECHNICAL ADVISORY COMMITTEE MEETING
June 26, 2006

LYNCHBURG AREA IMPAIRMENTS



WATERSHED WITHIN LOCALITIES

Locality	Locality Total Acreage	Watershed Acreage in County	% of County in Watershed
Amherst Co.	303,115	46,356	15.3%
Bedford Co.	489,729	29,400	6.0%
Campbell Co.	323,729	11,800	3.6%
Lynchburg City	31,661	31,661	100.0%

TMDL DEVELOPMENT PROCESS

- WATERSHED HISTORY
  - Characterize watershed and identify critical contamination conditions
- SOURCE ASSESSMENT
  - Identify and quantify pollutant sources
- MODELING
  - Link pollutant sources to stream water quality
- ALLOCATION
  - Develop and evaluate allocation scenarios

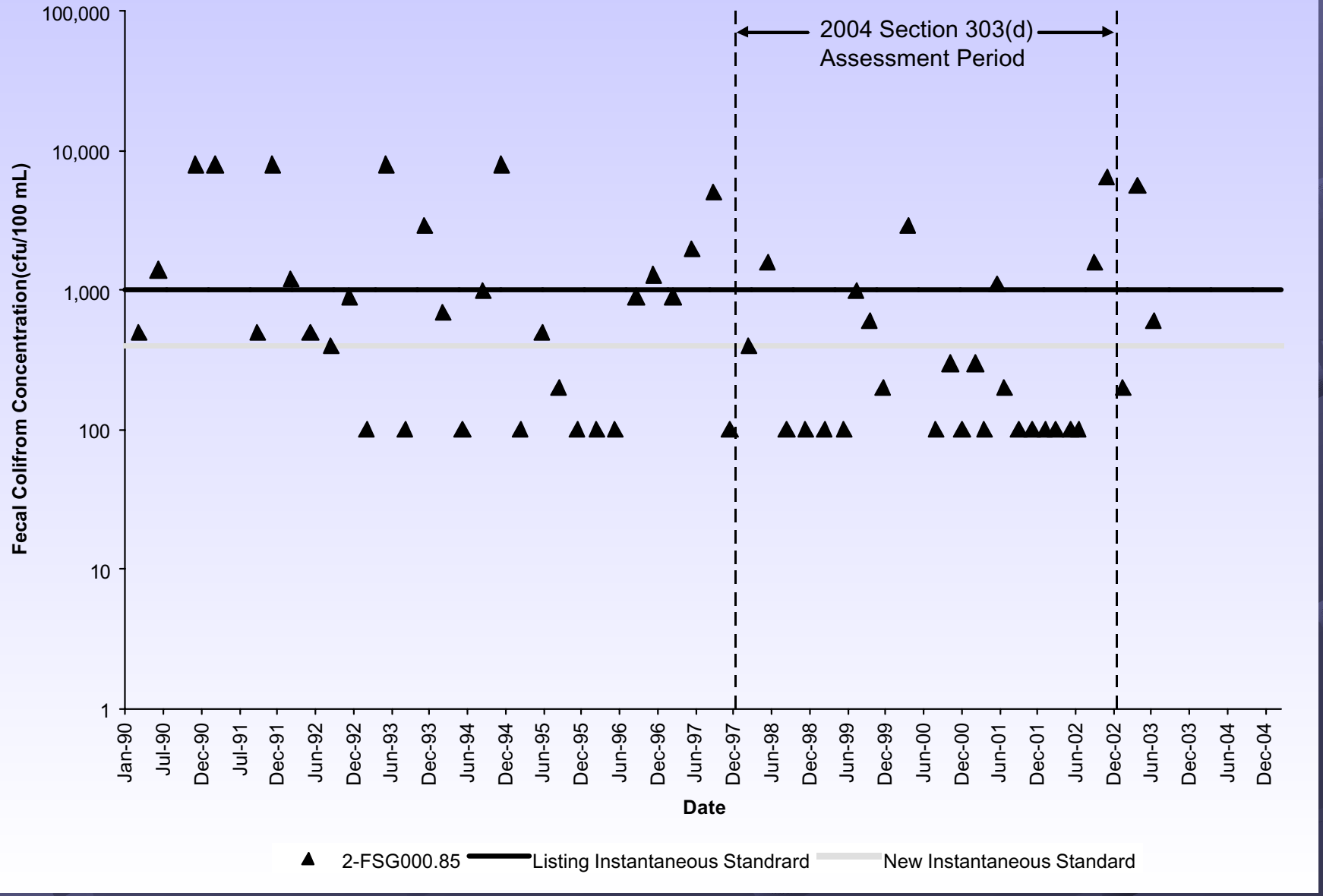
WATERSHED HISTORY

- Characterize watershed
  - Size
  - Land use
  - Slope
  - Soils and geology
  - Stream channel dimension
- Identify critical contamination conditions
  - Timeseries of bacteria concentration
  - Seasonality
  - Bacteria concentration versus flow

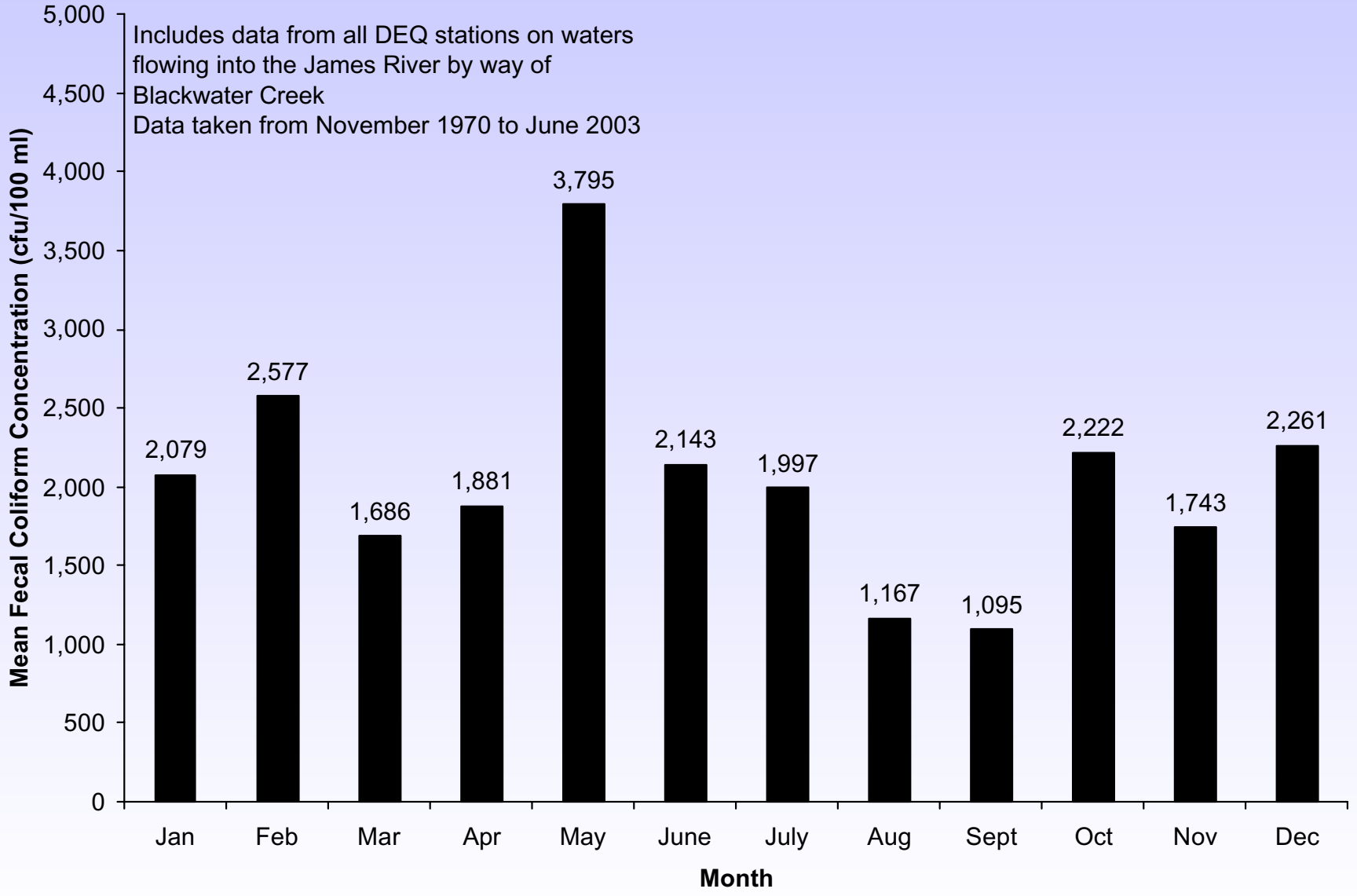
WATERSHED CHARACTERISTICS

Impairment	Drainage Size (sq. mi.)	Land use			
		Agricultural (%)	Residential/ Commercial (%)	Forest (%)	Water/ Wetland (%)
Ivy Creek (VAC-H03R-03)	37.4	28.7	7.1	63.4	0.8
Burton Creek (VAC-H03R)	10.3	14.2	39.3	46.0	0.5
Tomahawk Creek (VAC-H03R)	8.2	26.9	27.9	44.8	0.4
Blackwater Creek (VAC-H03R-01)	9.6	6.5	44.7	48.1	0.7
Fishing Creek (VAC-H03R-02)	7.2	7.0	54.7	38.1	0.2
Judith Creek (VAC-H03R)	13.1	15.1	5.8	78.5	0.6
James River (VAC-H03R-04)	100.4	16.4	6.7	74.4	2.4

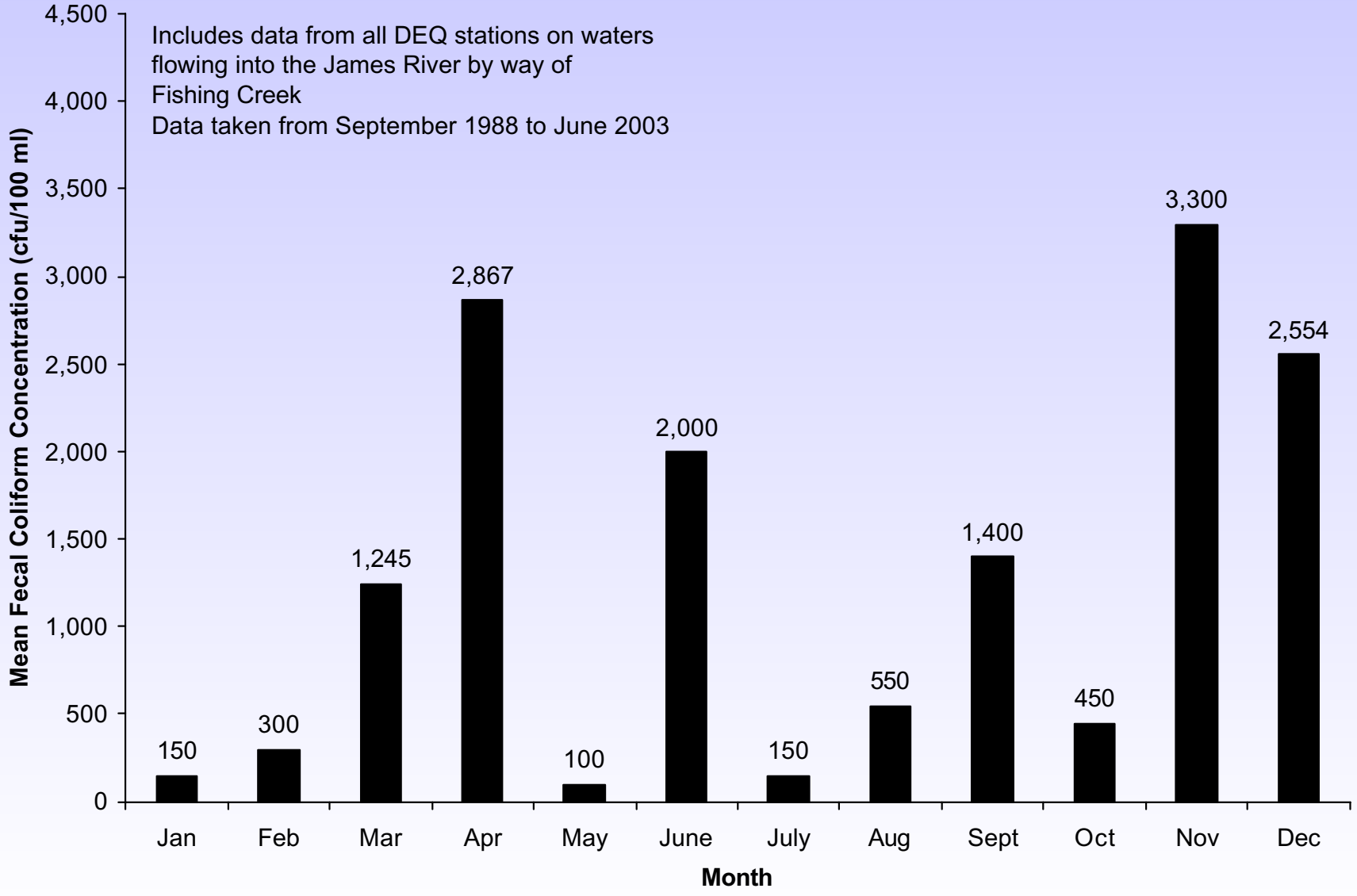
BACTERIA TIMESERIES
Fishing Creek (2-FSG000.85)



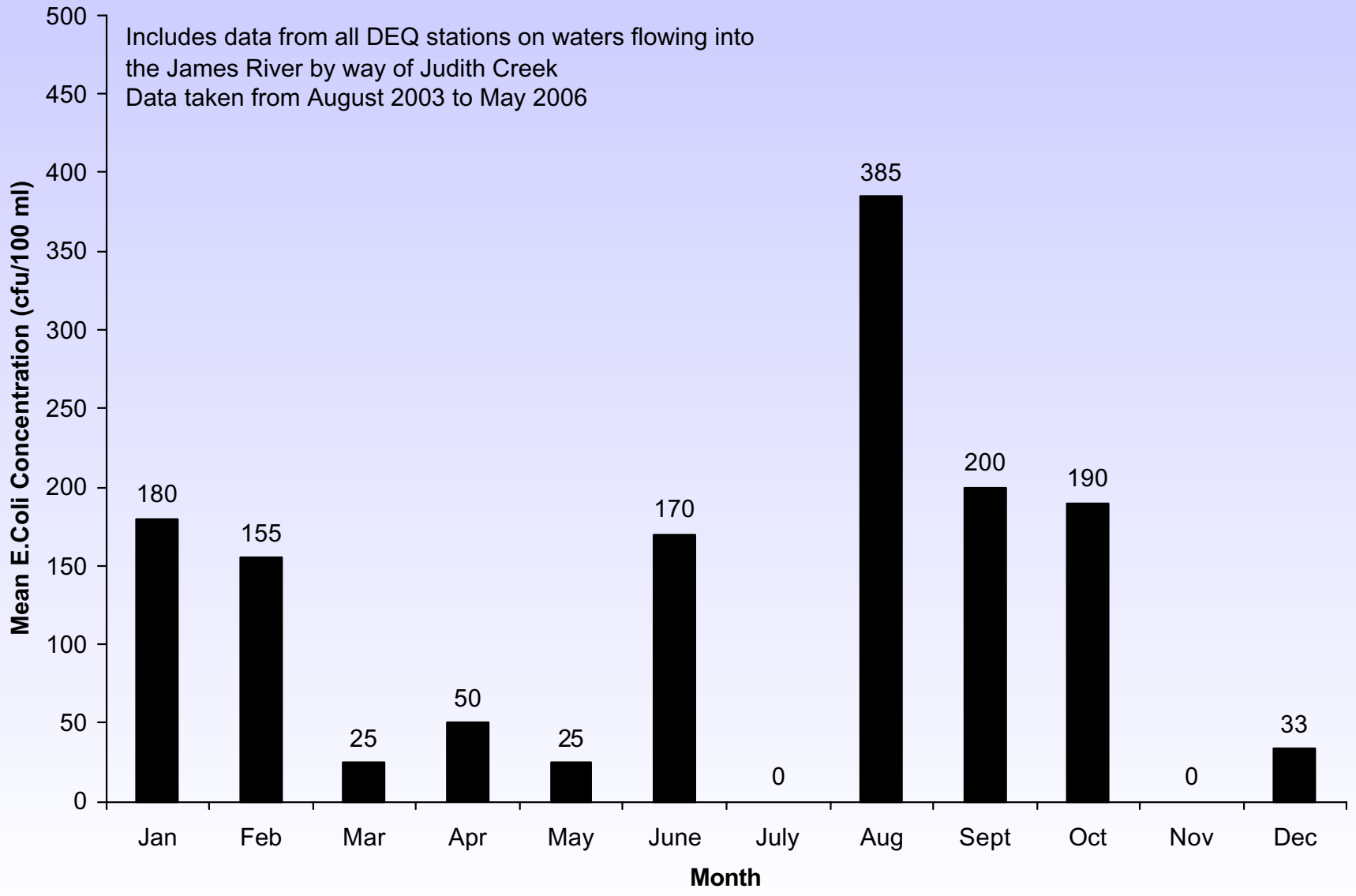
BACTERIA SEASONALITY
Blackwater Creek



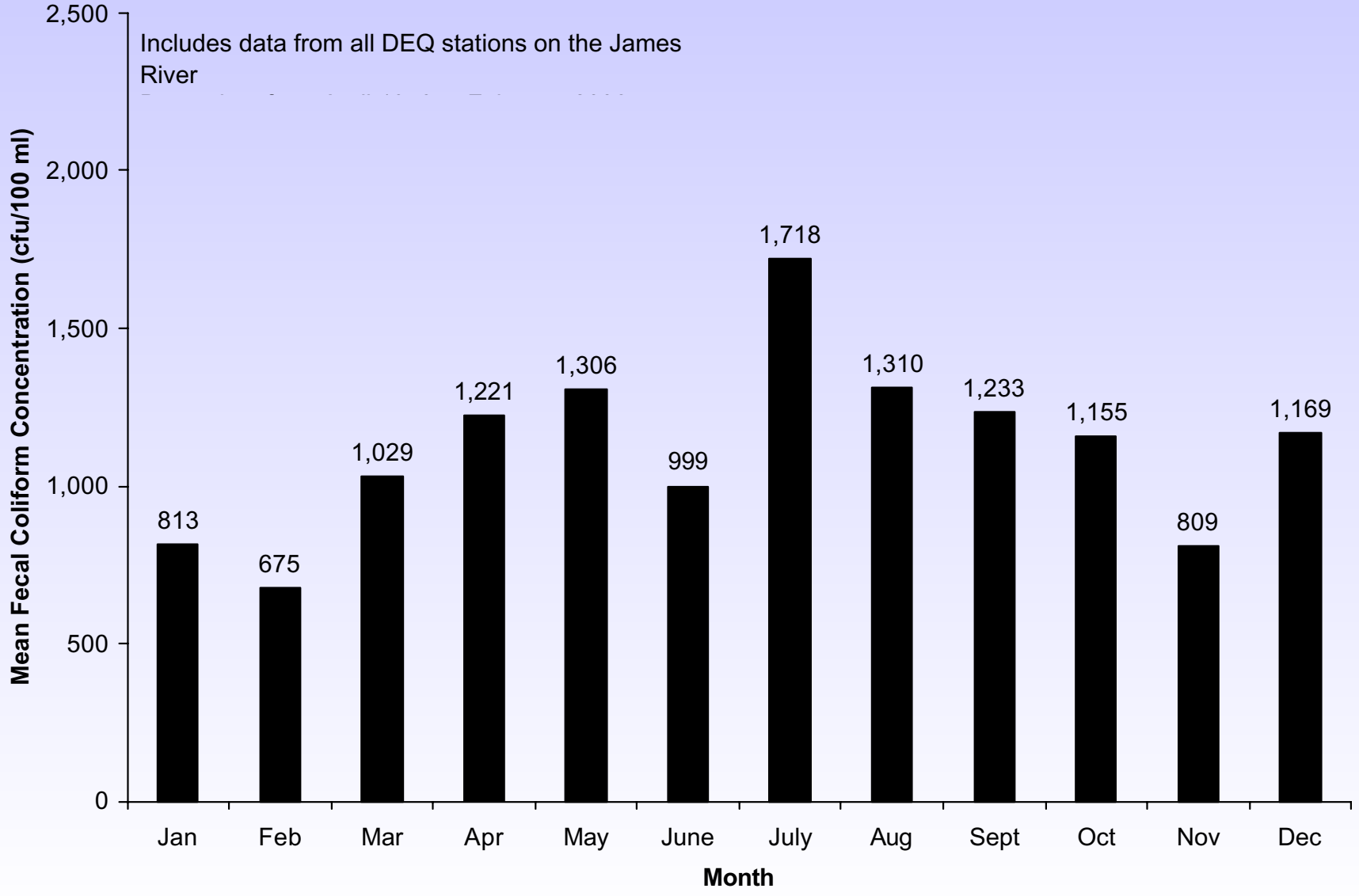
BACTERIA SEASONALITY
Fishing Creek



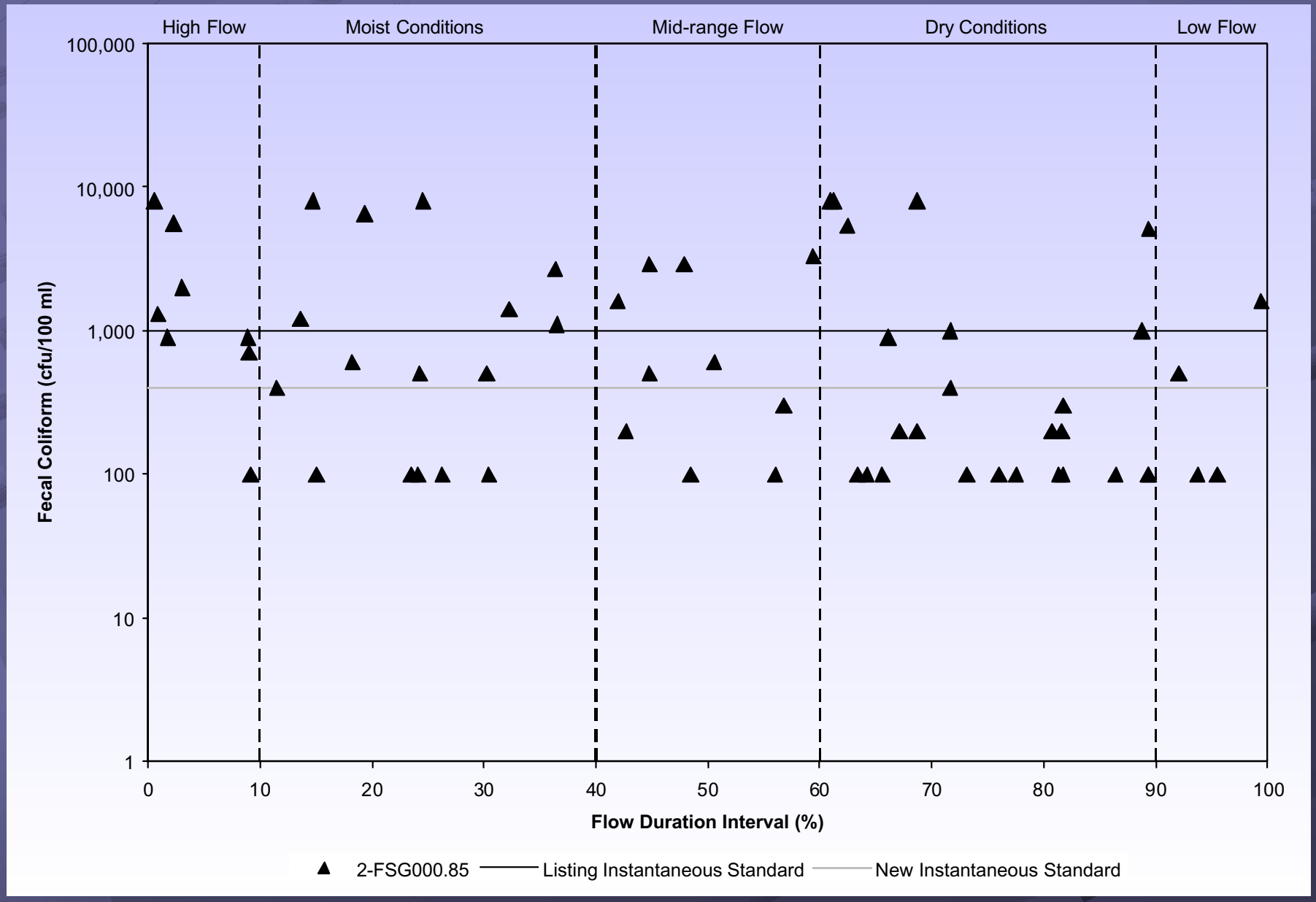
BACTERIA SEASONALITY
Judith Creek



BACTERIA SEASONALITY
James River



BACTERIA VS. FLOW
Fishing Creek (2-FSG000.85)



SOURCE ASSESSMENT

Source Category	Source / Animal Type
Human and Pets	Permitted Discharges
	Sanitary Sewer
	Straight Pipes
	Failing Septic Systems
	Biosolids Applications
	Dogs / Cats
Agricultural	Dairy & Beef Cattle
	Horses
	Swine
	Chicken
	Turkey
Wildlife	Deer
	Raccoon
	Muskrats
	Beavers
	Turkeys
	Geese
	Ducks

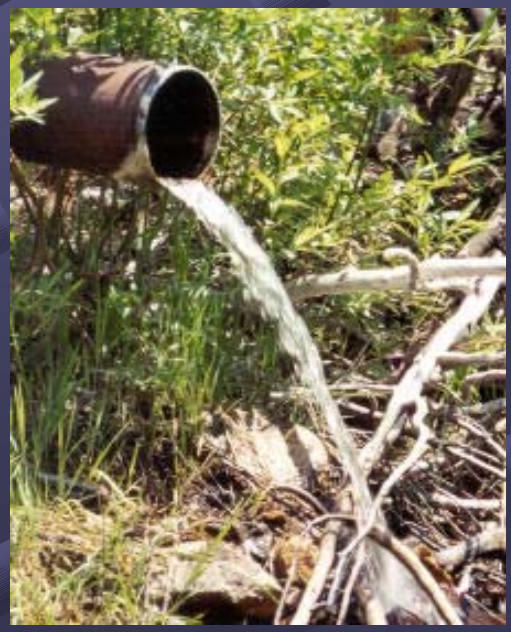
HUMAN SOURCES

- Population, houses, onsite treatment system based on U.S. Census Bureau, municipality, & E-911 data

- Sanitary sewer
  - Loading type
    - Overflows & exfiltration
      - Age, size, material of pipes
  - Land-applied / direct deposition
    - Loading type
    - Proximity to stream

PERMITTED POINT SOURCES

- Virginia Pollution Discharge Elimination System
  - Types
    - Municipal, industrial, general
    - Municipal separate storm sewer systems (MS4)
  - Categories – major, minor, general



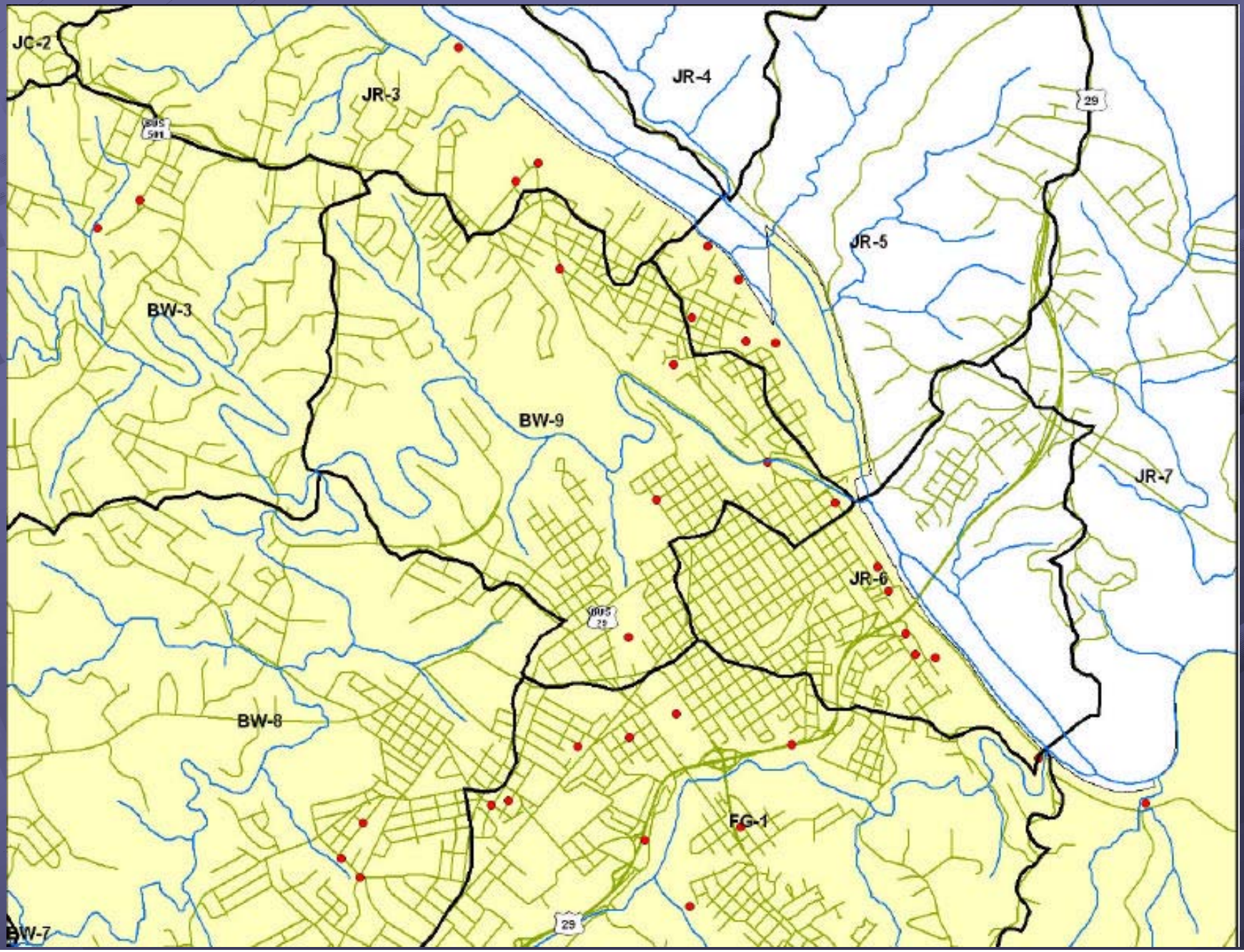
PERMITTED DISCHARGES

WATER BODY	PERMIT #	FACILITY NAME	FACILITY TYPE	FACILITY CATEGORY	DESIGN FLOW	PERMIT AVE. FLOW	RECEIVING STREAM
VAC-H03R	VA0063657	Amherst Co Service Auth-Ivanhoe Forest Sub	Municipal	Minor	0.0015	0.015	Fawn Creek, UT
VAC-H03R	VA0027618	US Department of Labor-Rescare Incorporated	Municipal	Minor	0.04	0.04	Harris Creek
VAC-H03R	VA0091162	Boonsboro Country Club	Municipal	Minor	0.015	0.015	Judith Creek, UT
VAC-H03R	VA0051888	Lynchburg City Abert Water Filtration Plant	Industrial	Minor	0.265	NL	James River, UT
VAC-H03R	VA0024970	Lynchburg City Sewage Treatment Plant	Municipal	Major	22	22	James River
VAC-H03R	VA0087114	American Electric Power - Reusens Hydro Plar	Industrial	Minor	0.177	NL	James River
VAC-H03R	VA0002925	Griffin Pipe Products Company - Lynchburg	Industrial	Minor	0.04	NL	James River

OTHER PERMITTED LOADS/DISCHARGES

- Municipal separate storm sewer systems (MS4s)
- Combined sewer overflow (CSO)
  - •132 original overflow points reduced to 35
  - •78% reduction in loading to streams
  - •Estimate 30 years to eliminate remaining 35 CSO overflow points
  - •2002 Annual load:
    - 88 MG flow
    - 1.0751 E+16 cfu fecal coliform

REMAINING CSO POINTS



HUMAN SOURCES

- Failed septic systems
  - Failure to soil surface throughout year
  - Failure rate based on age of home
- Straight pipes
  - Direct continuous input to stream
  - Based on proximity to stream and house age
- Biosolids applications
  - Records kept by Virginia Department of Health
  - Land-applied

Failed Septic System

Straight Pipe

PET SOURCES

- American Veterinary Medical Association estimates 0.53 dogs and 0.60 cats per household
- Potentially updated through veterinarians, animal control, treasurer, and residents
- Population = population density * houses
- Land-applied

HUMAN AND PET SOURCES

Impairment	Human Pop. (#)	Housing Unit (#)	Dogs (#)	Cats (#)
Ivy Creek (VAC-H03R-03)	15,977	6,506	3,449	3,905
Burton Creek (VAC-H03R)	13,374	4,576	2,427	2,747
Tomahawk Creek (VAC-H03R)	8,710	3,475	1,842	2,085
Blackwater Creek (VAC-H03R-01)	20,581	8,641	4,581	5,186
Fishing Creek (VAC-H03R-02)	9,350	3,737	1,981	2,243
Judith Creek (VAC-H03R)	3,633	1,385	735	832
James River (VAC-H03R-04)	25,600	9,773	5,183	5,866

LIVESTOCK SOURCES

- Population
  - Virginia Agricultural Statistics
  - Confined Animal Feeding Operation
  - Consultation with SWCD, VADCR, VCE, NRCS, and producers
  - Windshield survey
- Distribution of waste
  - Confined: waste collected and spread
  - Pastured: land-applied
  - Stream access: direct deposition
  - Imported sources
- Seasonal varying applications

LIVESTOCK SOURCES

Impairment	Beef* (#)	Dairy+ (#)	Horse (#)	Sheep (#)	Turkey (#)	Chicken (#)	Swine (#)
Ivy Creek (VAC-H03R-03)	748	80	143	0	0	0	0
Burton Creek (VAC-H03R)	30	0	2	0	0	0	0
Tomahawk Creek (VAC-H03R)	95	0	13	0	0	0	0
Blackwater Creek (VAC-H03R-01)	0	0	0	0	0	0	0
Fishing Creek (VAC-H03R-02)	0	0	0	0	0	0	0
Judith Creek (VAC-H03R)	146	0	28	0	0	0	0
James River (VAC-H03R-04)	1,728	0	217	0	0	0	0

* Cow/calf pairs; + Milking herd

WILDLIFE SOURCES

- Populations based on habitat and population densities provided by Virginia Department of Game and Inland Fisheries biologists
- Distribution of waste based on habitat
  - Land-applied
  - Direct deposition to stream
- Seasonal variations based on migration patterns and food sources



WILDLIFE SOURCES

Impairment	Deer (#)	Raccoon (#)	Muskrat (#)	Beaver (#)	Geese (#)	Duck (#)	Turkey (#)
Ivy Creek (VAC-H03R-03)	815	910	1,631	95	144	50	175
Burton Creek (VAC-H03R)	23	233	208	20	40	14	14
Tomahawk Creek (VAC-H03R)	69	195	228	18	31	11	18
Blackwater Creek (VAC-H03R-01)	4	199	67	18	37	13	9
Fishing Creek (VAC-H03R-02)	3	111	47	8	28	10	5
Judith Creek (VAC-H03R)	304	344	407	38	50	18	80
James River (VAC-H03R-04)	2,089	2,701	2,777	210	386	135	419

BACTERIAL SOURCE TRACKING

- Report provided by VADEQ
- Provides relative contribution of bacteria sources (i.e., human, pets, livestock, wildlife) to bacteria concentration in water samples
- Presence / Absence
  - 90% confidence that indicated proportions for each sample are within 15% of sampled population
  - Presence = proportional contribution > 15%

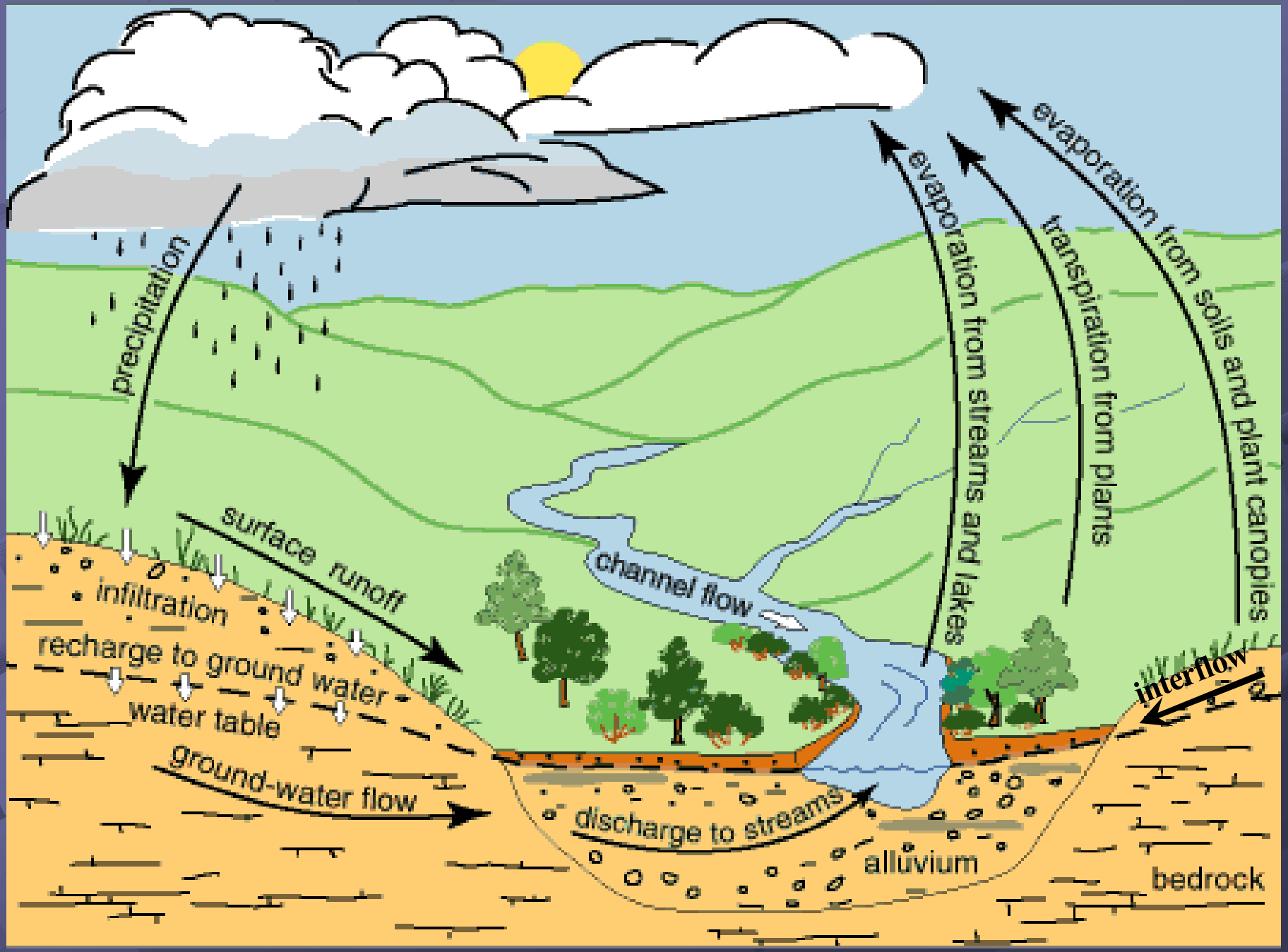
MODELING

- Link pollutant sources to stream water quality
- Approach includes use of JR-1
  - Upper limit of Middle James River watershed
  - No impairment – no reductions
- Mathematically represent processes that are occurring in the watershed
- Processes
  - Hydrology – water balance
  - Water quality - pollutant fate and transport
- Accuracy Evaluation
  - Based on observed data
    - Flow: USGS gauge = model output
    - Bacteria: VADEQ station = model output

MODELING

- Hydrologic Simulation Program - Fortran
  - Developed by USGS
  - Simulates point and non-point sources
  - Temporal variations in pollutant loadings
  - Seasonal patterns in climatic data

HYDROLOGIC MODELING



HYDROLOGIC MODELING COMPONENTS

- Land use
- Climatic data
- Topography
- Soils
- Stream channel characteristics
- Point source discharge / withdrawal
- Flow data

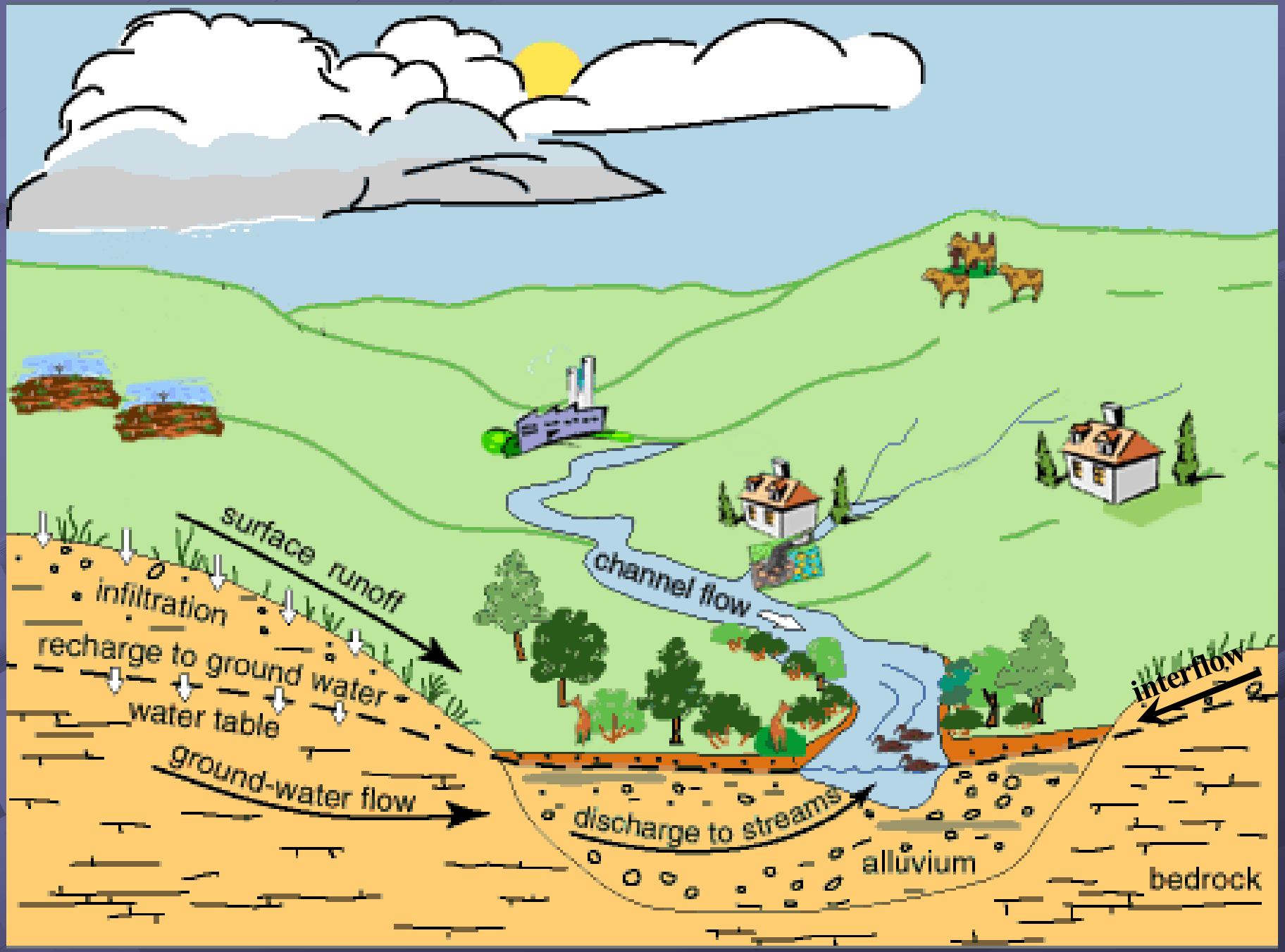
NCDC PRECIPITATION STATIONS

Station Name	COOP ID	Locality	Period of Record	
Lynchburg 7 St Brg	442155	Lynchburg	Aug-48	Present
Lynchburg No 2	442159	Lynchburg	Oct-97	Present
Lynchburg Regional Airport	440860	Lynchburg	Jun-34	Present

USGS GAUGING STATIONS

Site Number	Site Name	Period of Record From	To	Drainage (sq. mi.)
02025800	BURTON CREEK TRIBUTARY – PEAK FLOW ONLY	Feb-66	Mar-75	2.4
02025000	PEDLAR RIVER NEAR PEDLAR MILLS, VA	Oct-42	Sep-56	91.0
02025500	JAMES RIVER AT HOLCOMB ROCK, VA	Apr-27	present	3,259.0
02026000	JAMES RIVER AT BENT CREEK	Apr-27	present	3,683.0

WATER QUALITY MODELING



WATER QUALITY MODELING COMPONENTS

- Sources
  - Fecal production
  - Fecal coliform densities
  - Fecal coliform distribution
- Delivery mechanisms
  - Direct
  - Land-applied
- Temporal variation

DEQ MONITORING STATIONS

Impairment	DEQ Station
Ivy Creek (VAC-H03R-03)	2-IVA000.22
Burton Creek (VAC-H03R)	2-BUN001.64
Tomahawk Creek (VAC-H03R)	2-THK001.31
Blackwater Creek (VAC-H03R-01)	2-BKW000.40
Fishing Creek (VAC-H03R-02)	2-FSG000.85
Judith Creek (VAC-H03R)	2-JTH001.52
James River (VAC-H03R-04)	2-JMS258.54

ALLOCATION

- Calculate existing loads for all sources
- Create load reduction scenarios
- Run model with scenarios
- Calculate water quality standard (WQS) violation rate
- Select scenario with 0% WQS violation rate

EXAMPLE ALLOCATION

Source	Existing Condition Load (cfu/yr)
Direct	
Straight Pipes	8.09E+13
Livestock	1.76E+12
Wildlife	5.93E+13
Total	*1.58E+14*
Land-based	
Residential	1.61E+14
Cropland	1.16E+13
Pasture	9.53E+15
Forest	2.95E+14
Total	*9.99E+15*

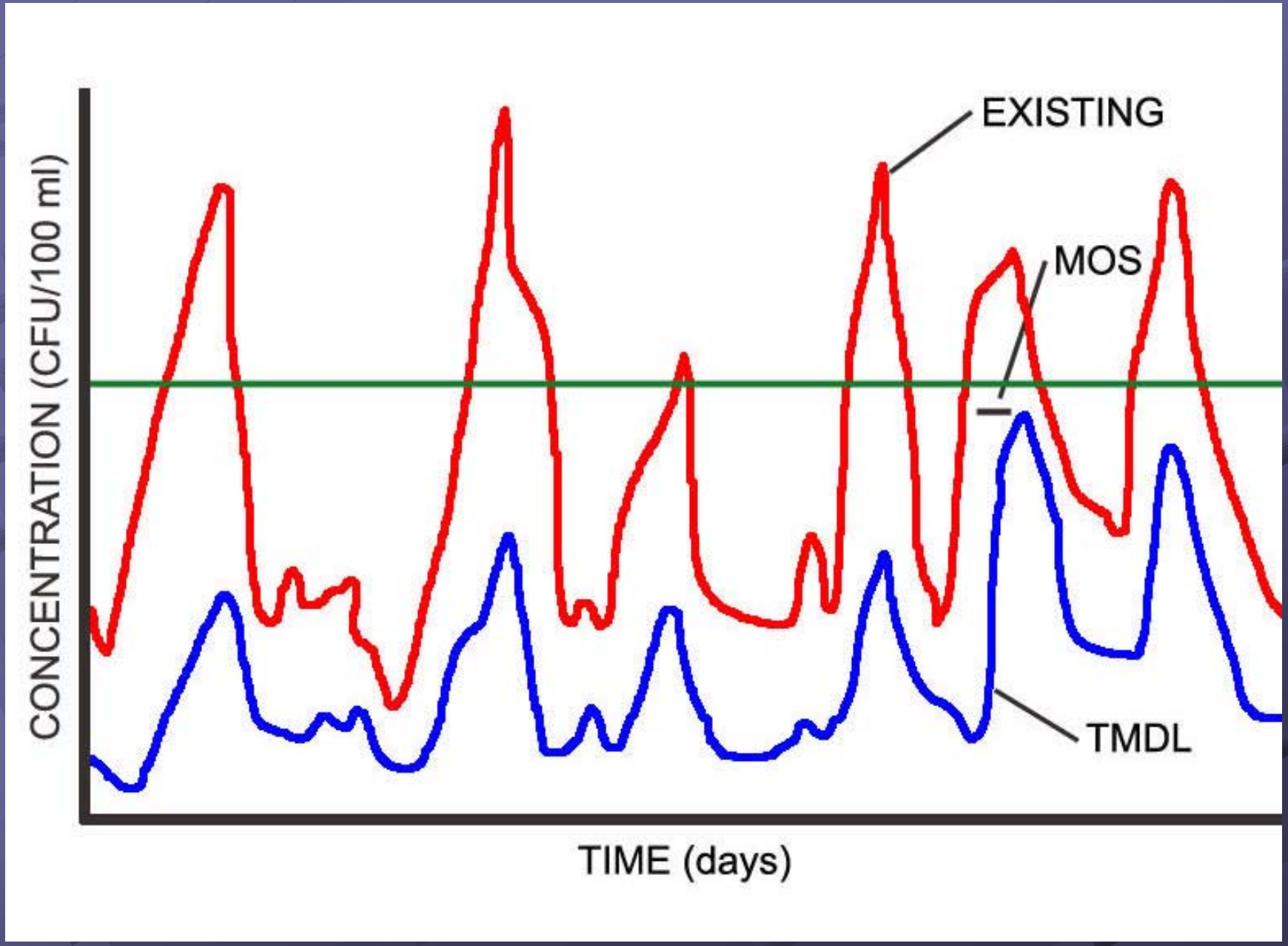
EXAMPLE ALLOCATION SCENARIOS

Scenario Number	Percent Reduction in Fecal Coliform Loading From Existing Conditions							% Violation of *E. coli* Standard	
	Straight Pipes	Livestock DD	Wildlife DD	Cropland	Pasture	Residential	Forest	Geometric Mean	Instantaneous
0	0	0	0	0	0	0	0	75	35
1	100	75	75	0	0	0	0	50	34
2	100	100	0	25	25	25	0	0	10
3	100	100	0	50	50	50	0	0	0

EXAMPLE ALLOCATION

Source	Existing Condition Load (cfu/yr)	TMDL Allocation Load (cfu/yr)	Scenario Reduction (%)
Direct			
Straight Pipes	8.09E+13	0.00E+00	100
Livestock	1.76E+12	0.00E+00	100
Wildlife	5.93E+13	5.93E+13	0
Total	*1.58E+14*	*5.93E+13*	
Land-based			
Residential	1.61E+14	8.05E+13	50
Cropland	1.16E+13	5.80E+12	50
Pasture	9.53E+15	4.77E+15	50
Forest	2.95E+14	2.95E+14	0
Total	*9.99E+15*	*5.15E+15*	

EXAMPLE TMDL



WHAT'S NEXT?

Modeling

- Hydrology calibration and validation

- ***First public meeting -*** Presentation of watershed history, pollutant source inventory, and modeling

- Additional modeling
  - Water quality model calibration and validation
- Allocation development
  - Scenario development, assessment of scenarios, selection of allocation

- ***Final public meeting -*** Presentation of model results, allocation scenarios, and draft TMDL document

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